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NPOESS Performance With Ka-band Stored Mission Data

EESS Wideband Downlink Workshop

March 25 – 27, 2003

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A Tri-agency Effort to Leverage and Combine Environmental Satellite Activities

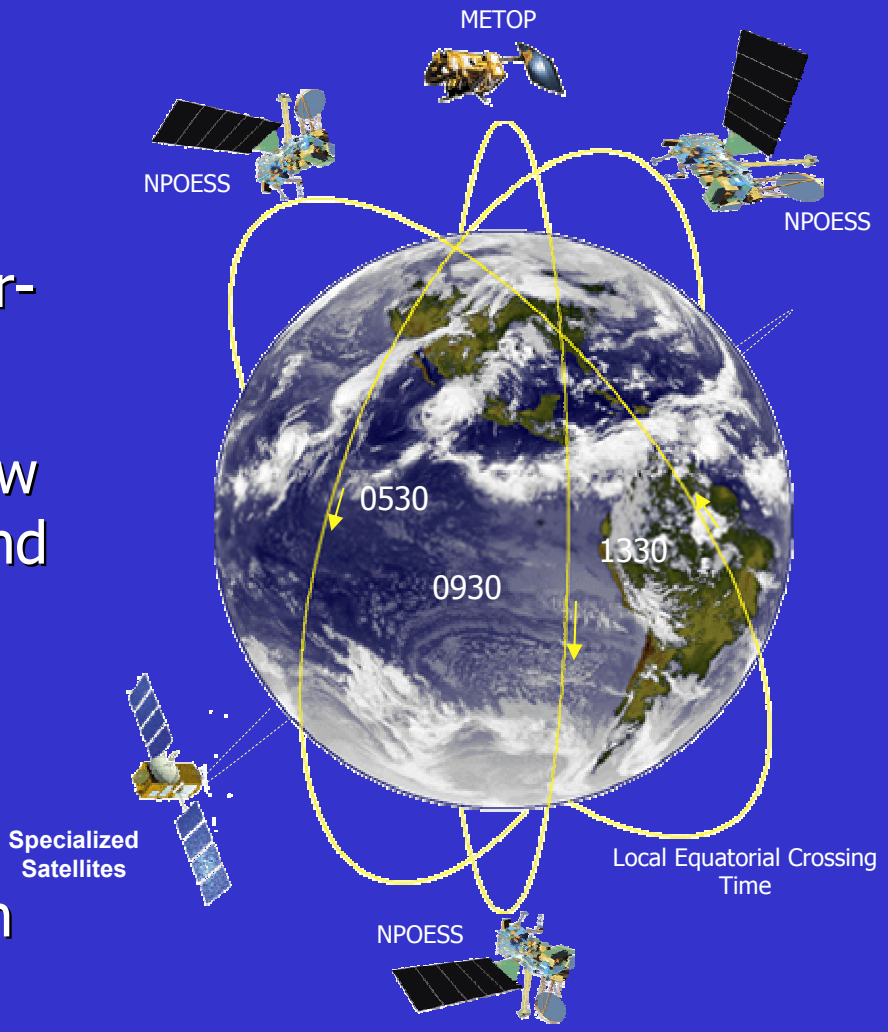
Mission

Provide a national, operational, polar-orbiting remote-sensing capability

Achieve National Performance Review (NPR) savings by converging DoD and NOAA satellite programs

Incorporate new technologies from NASA

Encourage International Cooperation



System Overview

- An Overview of the NPOESS and NPP programs were given on March 25 in the following session:

  Future Weather Systems Coriolis: Usage at 8070 GHz, NPOESS: Planned usage at 26.25 GHz

Presentation Focus

- Our program is the first non-GEO environmental satellite system to utilize Ka-band instead of X-band for stored mission data downlinking.
  - Advantage:
    - Avoid the crowded existing EESS frequencies at X band
    - Ka band better able to accommodate our bandwidth needs
  - Challenge:
    - Share the spectrum with other, non-EESS co-primary users

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NPOESS Segment Architecture

GPS

TDRSS

Space Segment

1330

NPP

1730

2130

Residual Satellites

ADCS

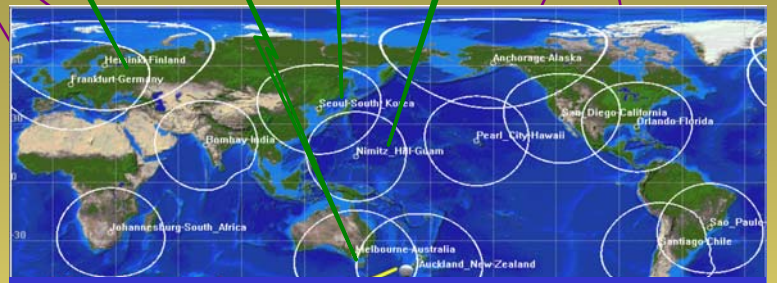
SARSAT

Field Terminal Segment

Launch Support Segment

Primary T&C

Backup T&C



15 Globally Distributed Receptor Sites

Supplied by NOAA

CLASS

ADS

SDS

Supplied by NASA

FNMOC NAVO AFWA NESDIS

Interface Data Processing Segment

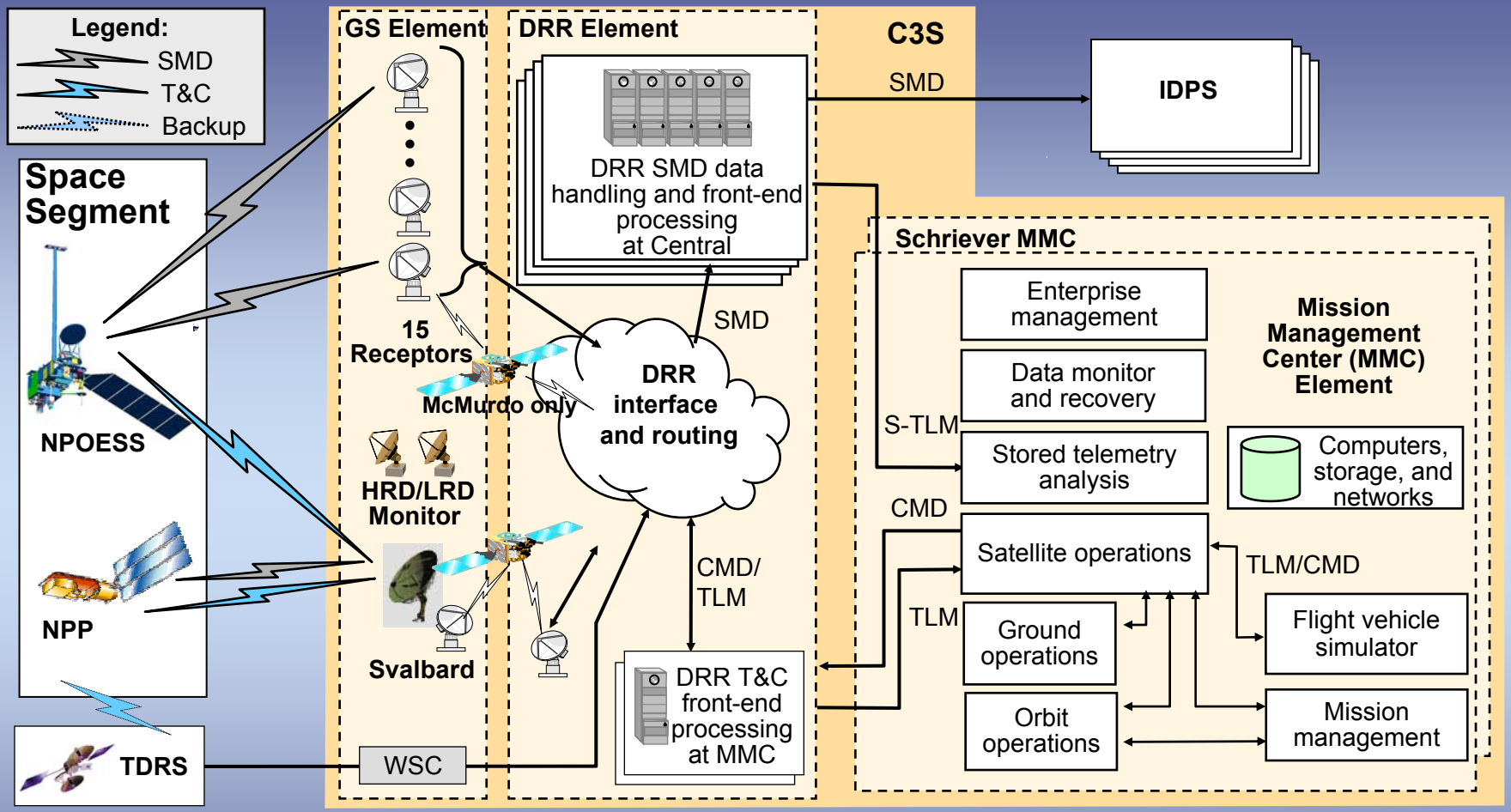
Data Handling Node Front End Processor

MMC at Suitland Flight Operations Team

MMC at Schriever Alternate Operations Team

C3 Segment

C3 Segment Architecture



Low-cost, reliable, and timely data delivery with flexibility to accommodate system growth and technology insertion

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Data Downlink and Processing

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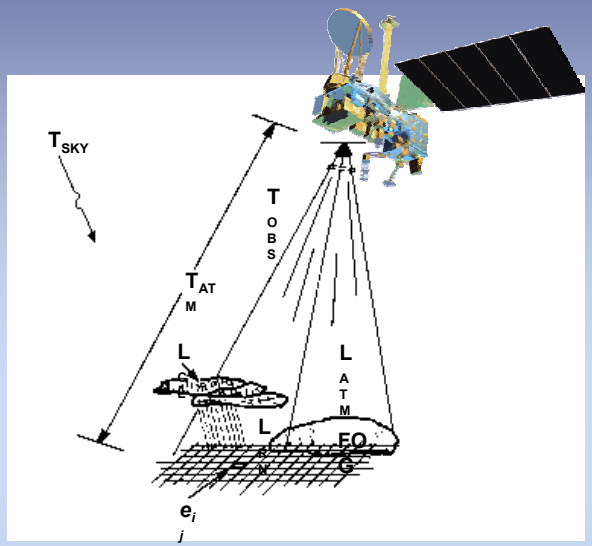
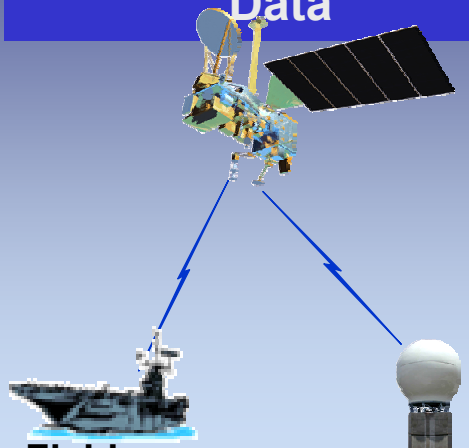
1. Sense Phenomena



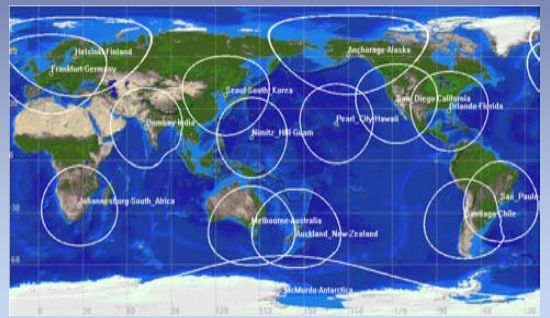
2. Downlink Raw Data



Field Terminals

SafetyNet* Receptors

3. Transport Data to Centrals for Processing



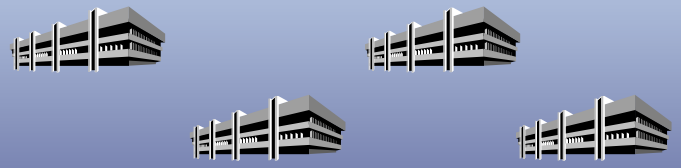
Global fiber network connects 15 receptors to Centrals

Monitor and Control Satellites and Ground Elements

Primary MMC

Alternate MMC

4. Process Raw data into EDRs and Deliver to Centrals



Full IDP Capability at each Central
NESDIS, AFWA, FNMOC, NAVO

•SafetyNet is patent pending by Northrop Grumman Space Technology

Operational Considerations

- Raw unprocessed data called Raw Data Records (RDR)
- Stored data downlinking priority for SafetyNet
  - New RDRs, not yet downlinked from space vehicle
  - RDRs sent from last receptor downlink session (stored at receptor and not automatically resent via WAN for processing)
  - Any RDR resend specifically requested from the mission control center via TT&C uplink
  - Live RDRs currently on space vehicle data bus

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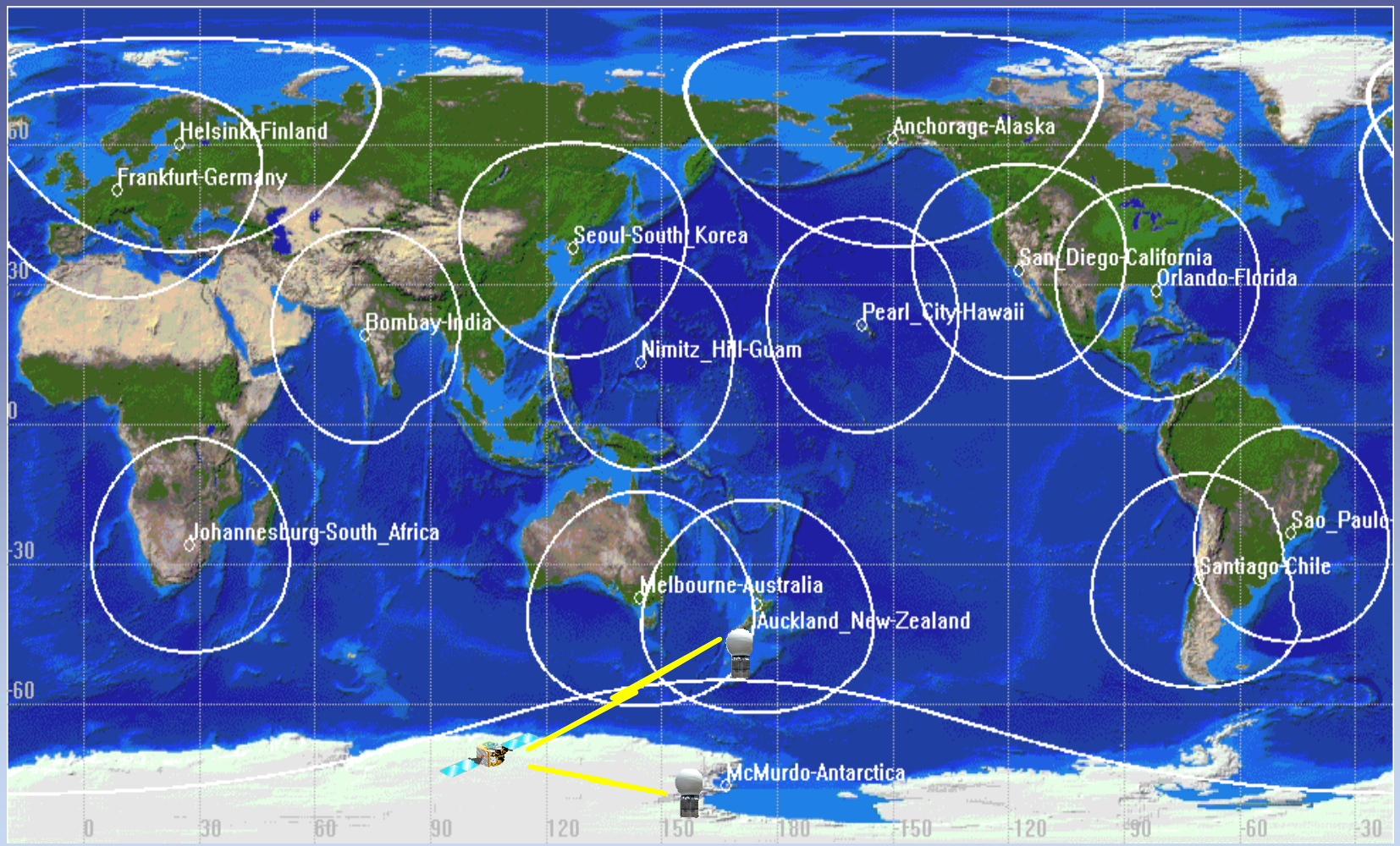
Proposed SafetyNet Architecture



SafetyNet* -- 15 globally distributed SMD receptors linked to the centrals via commercial fiber -- enables low data latency and high data availability

* Patent Pending

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SafetyNet Earth Station Configuration

- Antenna: 3.6 meter
- Full motion, 3-axis
- Similar to antennas used to support MODIS direct broadcast
- Accompanying hardware to include radome, receiver, data formatting and storage, network equipment to interface with private WAN
- 3 db minimum link budget margin for rain attenuation
- Co-located with commercial fiber access points

Ka Spectrum Utilization

- The SafetyNet concept utilizes a stored mission data downlink in the 25.5 to 27 GHz EESS (space-to-earth) band
  - First use by an environmental satellite for SMD in this band
  - Downlink requires about 300 MHz of the total 1.5 GHz spectrum in this band
  - Fifteen geographically-diverse, worldwide receive-only earth station locations utilized; Five stations US&P, Ten stations international
  - Hardware implementation with COTS
  - Unmanned operation

Frequency Allocation & Uses

Region 1	Region 2	Region 3
25.5 – 27 GHz	**EARTH EXPLORATION-SATELLITE** (space-to-Earth) 5.536A 5.536B **FIXED** **INTER-SATELLITE** 5.536 **MOBILE** Standard frequency and time signal-satellite (Earth-to-space)	

- ITU worldwide allocation for EESS (space-to-earth)
  - Co-primary with
    - Fixed (generally local wireless loop e.g., LMDS)
    - Mobile
    - Inter-Satellite (EESS and Space Research applications)
  - Additional secondary user: frequency & time uplink
- Potential for Space Research co-primary allocation post WRC-03

Foreign Frequency Allocations

- Since the receive earth stations must be licensed in each country, individual country tables must be consulted

Country	Allocation	Comment
Australia	Primary	
Brazil		Discretion of regulator
Chile	Secondary	
Finland	Secondary	
Germany	Secondary	
India	Primary	
New Zealand	Primary	Negotiation with private Management Rights Holders
South Africa	Primary	
South Korea		Discretion of regulator
US & P	Secondary	FCC NRPM 02-261 For change to primary

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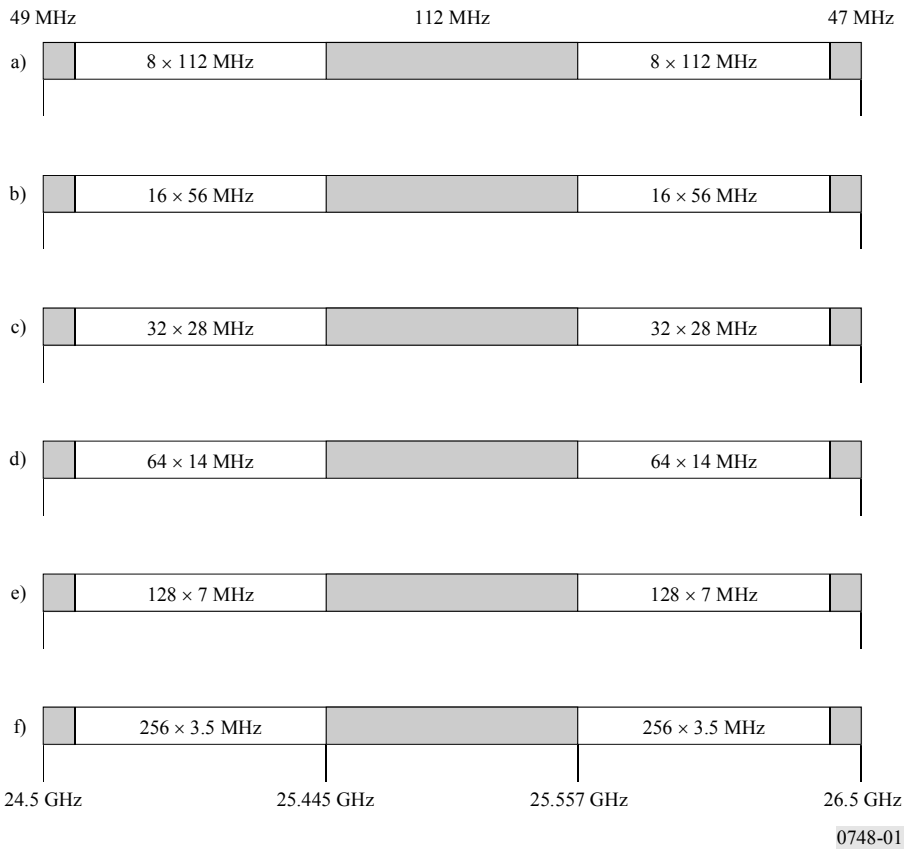
Ka Spectrum Availability

- Most foreign sites have plans to share this band with LMDS or MMDS (fixed) in accordance with ITU-R F.748-3
- Problem is complicated by existence of ITU footnote S5.536B
  - Gives EESS earth stations no priority over terrestrial services now or in the future in about 50 countries

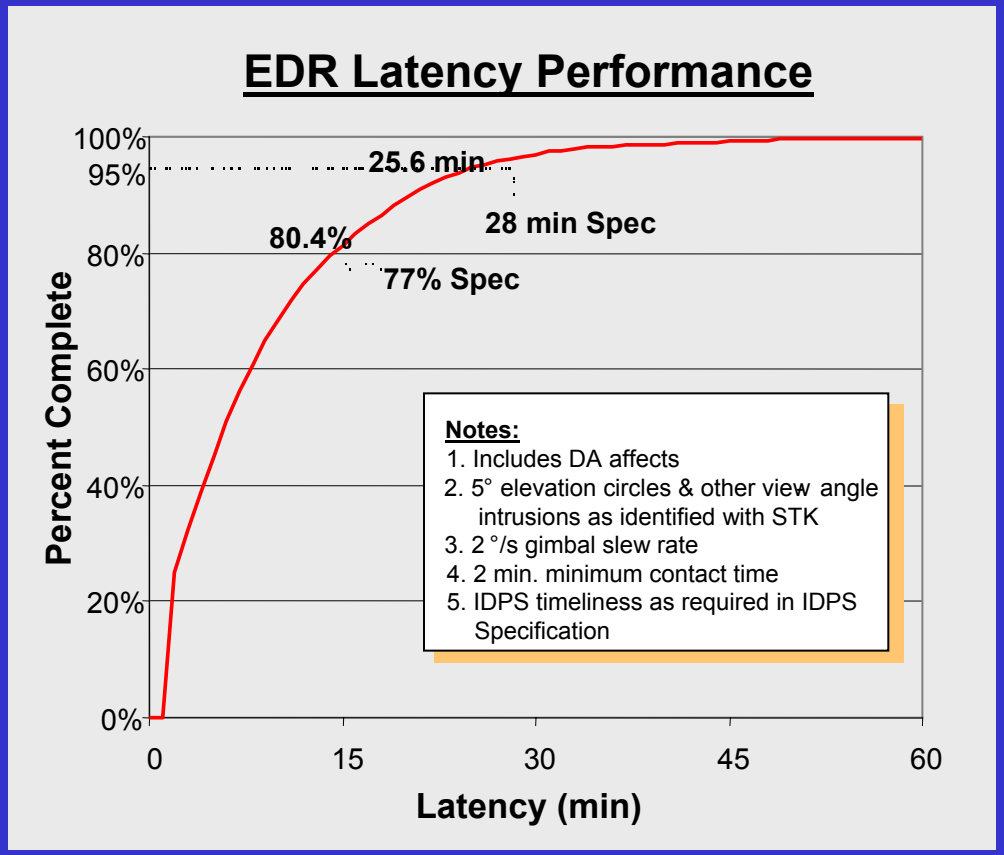
FIGURE 1



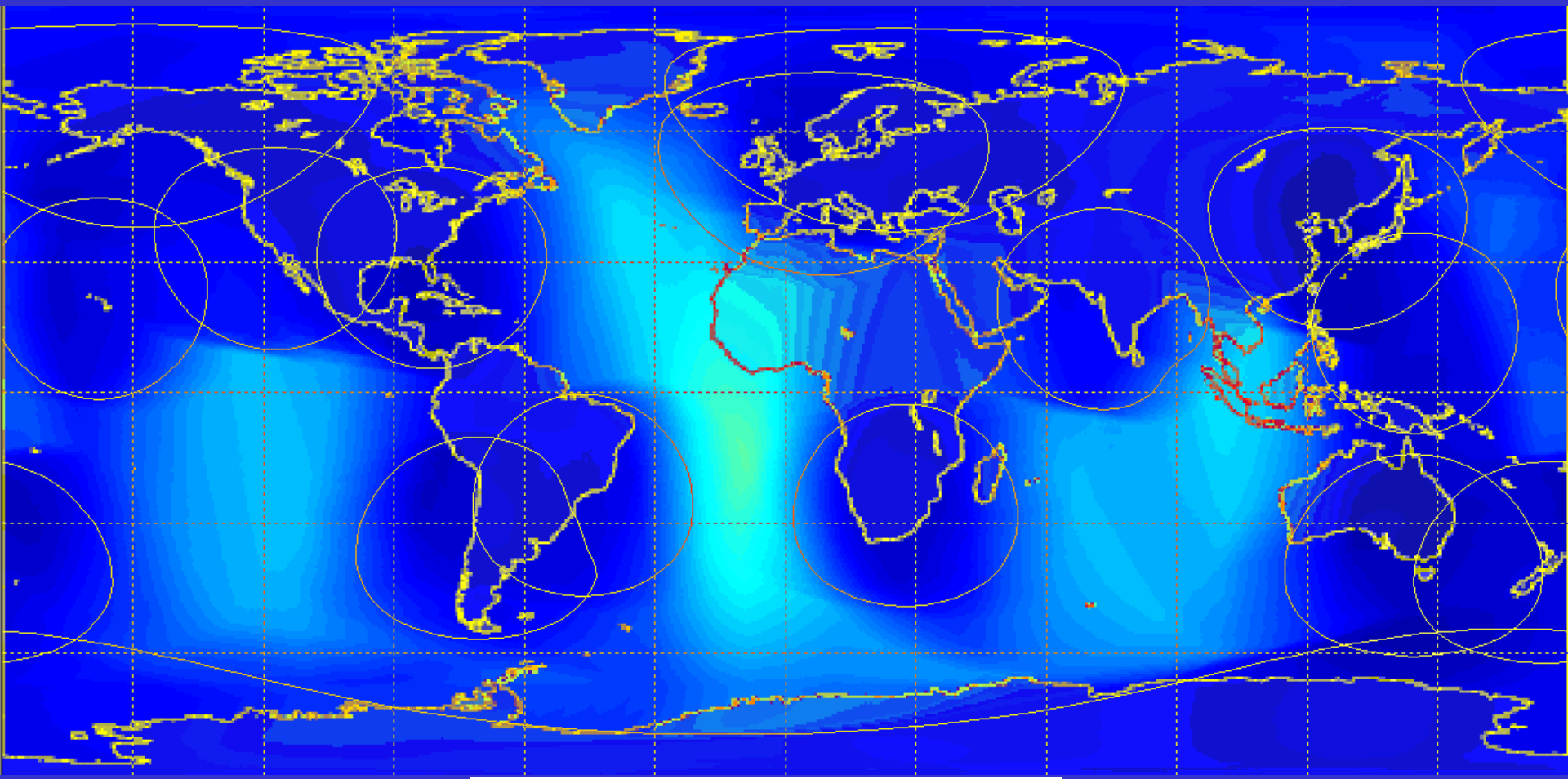
CEPT recommendations for terrestrial fixed channels in the 24.5 to 26.5 GHz band

Receptor Siting Considerations

- System Performance: Data Latency
  - 28 minutes, 95%
- Availability of Frequency Allocation
  - Shared with fixed (LMDS) and mobile, ISS
- Non-spectrum Regulatory Issues
  - telecom licensing, zoning
- Communications costs
  - Proximity to NPOESS WAN network provider



Baseline Average Latency



NPOESS Data Downlink Summary

- SafetyNet architecture is unique and innovative
  - Satellite has visibility to a receptor significant percentage of the time
  - Loss of a given receptor has little impact on system performance
  - System can be easily expanded by adding new receptor
- Moves from crowded X-band to Ka-band, making efficient use of spectrum
- Flexible design for ease of expansion, using COTS hardware and existing commercial WAN
- Timeliness of receipt of raw environmental data for processing is greatly improved over current systems